CONTROL STABILITY SYSTEM FOR MOIST AIR DEHUMIDIFICATION UNITS AND METHOD OF OPERATION

FIELD OF THE INVENTION

[0001] The present invention relates generally to controlling refrigerant flow into an air conditioning system having a hot gas reheat circuit, and specifically for controlling the amount of refrigerant flowing into the reheat circuit based on outdoor and indoor ambient conditions.

BACKGROUND OF THE INVENTION

[0002] Air delivery systems, such as used in commercial applications, typically are systems that can be used to cool or to accomplish dehumidification when ambient conditions are such that there is no demand for cooling. This demand for dehumidification can often occur on days when the temperature is cool and there is a high humidity level, such as damp, rainy spring and fall days. Under such conditions, it may be necessary to switch the operation of the air delivery system from cooling mode to dehumidification mode.

[0003] When switching an air delivery system, such as are used in commercial applications, from the cooling mode to the dehumidification mode in a reheat system that includes a reheat coil and a condenser coil configured in a parallel arrangement, some refrigerant will become trapped in the condenser coil. As the outdoor temperature falls, the amount of refrigerant that becomes trapped in the condenser coil will increase, resulting in a drop in the quantity of refrigeration available in the remainder of the refrigerant system to accomplish dehumidification. Without adequate refrigerant in the dehumidification circuit, operational problems will occur with the air delivery system. Some refrigerant can become trapped in a system that includes a reheat circuit even on warm days when dehumidification is required, but cooling is not required. The refrigerant can become trapped in the condenser coil, and if switching is required to the cooling mode, additional refrigerant can be trapped in the reheat circuit.

[0004] One of the problems is decreased system capacity as the refrigerant normally available in a properly operating system is trapped in the condenser coil and not available to the compressor. Associated with this problem is inadequate suction pressure at the compressor, since the gas refrigerant that normally is available to the compressor from the evaporator is trapped as a liquid in the condenser. A solution to the problem of refrigerant trapped as a liquid in a condenser or in a reheat heat exchanger is set forth in U.S. Patent Application No. U.S. 2004/0089015 A1, based on U.S. Ser. No. 10/694,316 to Knight et al., filed Oct. 27, 2003, now allowed, ("the Knight application") and assigned to the assignee of the present invention, which allowed application is incorporated herein by reference.

[0005] The system described in the Knight application utilizes a system having a reheat circuit in which a hot gas reheat exchanger is coupled to an evaporator and a compressor, but which does not include a condenser. A separate cooling circuit utilizes a compressor, a condenser and an evaporator. The evaporator and compressor may be shared between the two circuits, when suitable valving is used to isolate the circuits. As discussed in the Knight application, the system may be combined with additional cooling circuits, as required. Thus, systems having more than one compressor are envisioned, and these compressors also may be coupled to additional reheat circuits. Although such complex systems are envisioned by the Knight application and the present invention, both the Knight application and the present invention are readily understood without reference to these more complex arrangements, as one skilled in the art can readily adapt the simpler concepts of the Knight application and the present invention to such complex arrangements.

[0006] In order for the reheat circuit to operate efficiently and properly, the hot gas reheat exchanger must be suitably sized in relation to the evaporator. Generally, the properly sized hot gas reheat exchanger is smaller than the condenser that is included in the cooling circuit that shares the same condenser and evaporator. The result is that when the cooling circuit is inactivated and the reheat circuit is activated to accomplish dehumidification, excess refrigerant can be directed into the reheat circuit. The Knight application, while implicitly recognizing the need to balance the size of the hot gas reheat coil against the size of the evaporator coil, explicitly addresses the problem of refrigerant, which is also shared by the cooling circuit and the reheat circuit, trapped in the inactivated circuit. However, it fails to address the problem of refrigerant being drawn into the activated circuit. Excess refrigerant drawn into a circuit can result in operational problems which should be avoided. One of these problems is unacceptable discharge pressures from the compressor, which can lead to decreased system efficiency. If the amount of excess refrigerant drawn into the activated circuit is too great, slugging can also be a problem. Slugging is a condition in which liquid refrigerant is drawn into the compressor. These operational problems can result in a severe reduction in compressor life, and in the worst circumstances, to premature compressor failure.

[0007] What is needed is a system that can readily and rapidly accommodate the difference in refrigerant capacity between the reheat circuit and the cooling circuit to avoid these operational problems without having to resize or otherwise reengineer the hot gas reheat coil or the condenser coil.

SUMMARY OF THE INVENTION

[0008] The present invention utilizes a system having an independent hot gas reheat circuit and a cooling circuit. The hot gas reheat circuit includes a compressor, an evaporator and a hot gas reheat coil. The hot gas reheat coil is engineered to work in conjunction with the evaporator to provide a sufficient rise in temperature of air that has been cooled after passing over the evaporator. The cooling circuit, which is isolable from the reheat circuit, includes a condenser, and shares the compressor, the evaporator and refrigerant with the reheat circuit. The hot gas reheat coil is generally sized to accommodate sufficiently less refrigerant than the condenser.

[0009] The present invention controls the amount of refrigerant entering into a first circuit from a second circuit, wherein the first circuit is being activated and the second circuit is being inactivated. This control is of particular importance when the activated circuit has less refrigerant capacity than the inactivated circuit.